

T03D07 – HL Periodicity Exam

Name.....

1. Which general trends are correct for the oxides of the period 3 elements (Na_2O to Cl_2O)?
- Acid character decreases.
 - Electrical conductivity (in the molten state) decreases.
 - Bonding changes from ionic to covalent.
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III
2. Which of the reactions below occur as written?
- $\text{Br}_2 + 2\text{I}^- \rightarrow 2\text{Br}^- + \text{I}_2$
 - $\text{Br}_2 + 2\text{Cl}^- \rightarrow 2\text{Br}^- + \text{Cl}_2$
- A. I only
B. II only
C. Both I and II
D. Neither I nor II
3. When the following species are arranged in order of **increasing** radius, what is the correct order?
- A. Cl^- , Ar, K^+
B. K^+ , Ar, Cl^-
C. Cl^- , K^+ , Ar
D. Ar, Cl^- , K^+
4. Which property decreases down group 7 in the periodic table?
- A. atomic radius
B. electronegativity
C. ionic radius
D. melting point
5. Which series is arranged in order of **increasing** radius?
- A. $\text{Ca}^{2+} < \text{Cl}^- < \text{K}^+$
B. $\text{K}^+ < \text{Ca}^{2+} < \text{Cl}^-$
C. $\text{Ca}^{2+} < \text{K}^+ < \text{Cl}^-$
D. $\text{Cl}^- < \text{K}^+ < \text{Ca}^{2+}$
6. What increases in **equal steps of one** from left to right in the periodic table for the elements lithium to neon?
- A. the number of occupied electron energy levels
B. the number of neutrons in the most common isotope
C. the number of electrons in the atom
D. the atomic mass
7. Which **two** elements react most vigorously with each other?
- A. chlorine and lithium
B. chlorine and potassium
C. iodine and lithium
D. iodine and potassium
8. Which properties are typical of most non-metals in period 3 (Na to Ar)?
- They form ions by gaining one or more electrons.
 - They are poor conductors of heat and electricity.
 - They have high melting points.
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III

9. Which factors lead to an element having a low value of first ionization energy?
- large atomic radius
 - high number of occupied energy levels
 - high nuclear charge
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III
10. Which statement is correct for a periodic trend?
- A. Ionization energy increases from Li to Cs.
B. Melting point increases from Li to Cs.
C. Ionization energy increases from F to I.
D. Melting point increases from F to I.
11. Which statement about electronegativity is correct?
- A. Electronegativity decreases across a period.
B. Electronegativity increases down a group.
C. Metals generally have lower electronegativity values than non-metals.
D. Noble gases have the highest electronegativity values.
12. Which compound of an element in period 3 reacts with water to form a solution with a pH greater than 7?
- A. SiO_2
B. SiCl_4
C. NaCl
D. Na_2O
13. A potassium atom has a larger atomic radius than a sodium atom. Which statement about potassium correctly explains this difference?
- A. It has a larger nuclear charge.
B. It has a lower electronegativity.
C. It has more energy levels occupied by electrons.
D. It has a lower ionization energy.
14. Which equation represents the first ionization energy of fluorine?
- A. $\text{F(g)} + \text{e}^- \rightarrow \text{F}^-(\text{g})$
B. $\text{F}^-(\text{g}) \rightarrow \text{F(g)} + \text{e}^-$
C. $\text{F}^+(\text{g}) \rightarrow \text{F(g)} + \text{e}^-$
D. $\text{F(g)} \rightarrow \text{F}^+(\text{g}) + \text{e}^-$
15. Which of the following statements are correct?
- The melting points decrease from $\text{Li} \rightarrow \text{Cs}$ for the alkali metals.
 - The melting points increase from $\text{F} \rightarrow \text{I}$ for the halogens.
 - The melting points decrease from $\text{Na} \rightarrow \text{Ar}$ for the period 3 elements.
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III
16. Which oxides produce an acidic solution when added to water?
- SiO_2
 - P_4O_6
 - SO_2
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III
17. Which element is a transition metal?
- A. Ca
B. Cr
C. Ge
D. Se

18. When Na, K, and Mg are arranged in **increasing** order of atomic radius (smallest first), which order is correct?
- Na, K, Mg
 - Na, Mg, K
 - K, Mg, Na
 - Mg, Na, K
19. Which electrons are lost by an atom of iron when it forms the Fe^{3+} ion?
- One s orbital electron and two d orbital electrons
 - Two s orbital electrons and one d orbital electron
 - Three s orbital electrons
 - Three d orbital electrons
20. Which equation represents the third ionization energy of an element M?
- $\text{M}^+(g) \rightarrow \text{M}^{4+}(g) + 3e^-$
 - $\text{M}^{2+}(g) \rightarrow \text{M}^{3+}(g) + e^-$
 - $\text{M}(g) \rightarrow \text{M}^{3+}(g) + 3e^-$
 - $\text{M}^{3+}(g) \rightarrow \text{M}^{4+}(g) + e^-$
21. Which is an essential feature of a ligand?
- a negative charge
 - an odd number of electrons
 - the presence of two or more atoms
 - the presence of a non-bonding pair of electrons
22. Which properties are typical of d-block elements?
- complex ion formation
 - catalytic behavior
 - colorless compounds
- I and II only
 - I and III only
 - II and III only
 - I, II and III
23. Which salts form colored solutions when dissolved in water?
- FeCl_3
 - NiCl_2
 - ZnCl_2
- I and II only
 - I and III only
 - II and III only
 - I, II and III
24. Table 6 of the Data Booklet lists melting points of the elements. Explain the trend in the melting points of the alkali metals, halogens and period 3 elements.

(Total 8 marks)

25. State and explain the trends in the atomic radius and the ionization energy
(i) for the alkali metals Li to Cs.

(4)

- (ii) for the period 3 elements Na to Cl.

(4)

(Total 8 marks)

26. By reference to the structure and bonding in the compounds NaCl and SiCl₄
(i) state and explain the differences in conductivity in the liquid state.

(3)

- (ii) predict an approximate pH value for a solution formed by adding each compound separately to water.

(4)

(Total 7 marks)

27. Consider the transition metal complex, K₃[Fe(CN)₆].

- (i) Define the term *ligand*, and identify the ligand in this complex.

(1)

- (ii) Write the full electron configuration and draw the orbital box diagram of iron in its oxidation state in this complex, and hence, determine the number of unpaired electrons in this state.

(3)

- (iii) Explain why many transition metal d-block complexes are colored.

(3)

(Total 7 marks)

28. (a) Use the Aufbau principle to write the electron configuration of an atom of germanium.

(1)

(b) The successive ionization energies of germanium are shown in the following table:

	1st	2nd	3rd	4th	5th
Ionization energy / kJ mol^{-1}	760	1540	3300	4390	8950

(i) Identify the sub-level from which the electron is removed when the first ionization energy of germanium is measured.

(1)

(ii) Write an equation, including state symbols, for the process occurring when measuring the second ionization energy of germanium.

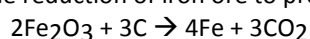
(1)

(iii) Explain why the difference between the 4th and 5th ionization energies is much greater than the difference between any two other successive values.

(2)

(Total 5 marks)

29. The reaction below represents the reduction of iron ore to produce iron.



A mixture of 30 kg of Fe_2O_3 and 5.0 kg of C was heated until no further reaction occurred.

Calculate the maximum mass of iron that can be obtained from these masses of reactants.

(Total 5 marks)